Kwadropus Suction Cups

8Congratulations for being chosen to be a NASA HUNCH Finalist for Design and Prototyping. Know that there were a lot of very good teams with great ideas competing for these spaces. Being a Finalist means you are already a winner. There is not a 1st, 2nd, or 3rd place—there are only Finalists. Although HUNCH would like to have all of these projects turned into flight hardware, most won't make it that far. However, some of these ideas may inspire other hardware and equipment. This is like real engineering where any of the projects or ideas in a project that are deemed valuable to NASA could be incorporated into another project. NASA has no intention of taking or stealing ideas. HUNCH has every intention to keep your names attached to those projects so that you and your team retain credit for your ideas and efforts. In general, NASA does not seek patents on space hardware unless there is a use for it on the ground that could be valuable.

Suggestions for the Final Design Review

Houston in the middle of April is warm and humid. The building is air conditioned but there will be lots of people. Rain is possible.

- Look professional.
- Everyone on the team should plan to talk.
- Update your brochure with you latest prototype and information.
- Make sure your QR code works for everyone.
- Update your tri-fold with your latest information—less about early concepts, more about features.
- The better your model looks, the less you have to say.
- Take a video of everything working well so if it fails when you arrive, you can still show functionality.
- You will be sharing a table with another team. Make sure your display will not take up more than half of a 6 ft x 2ft table. There will be some tables with power and some without. We will try to give priority to those who need it for the presentation—video.

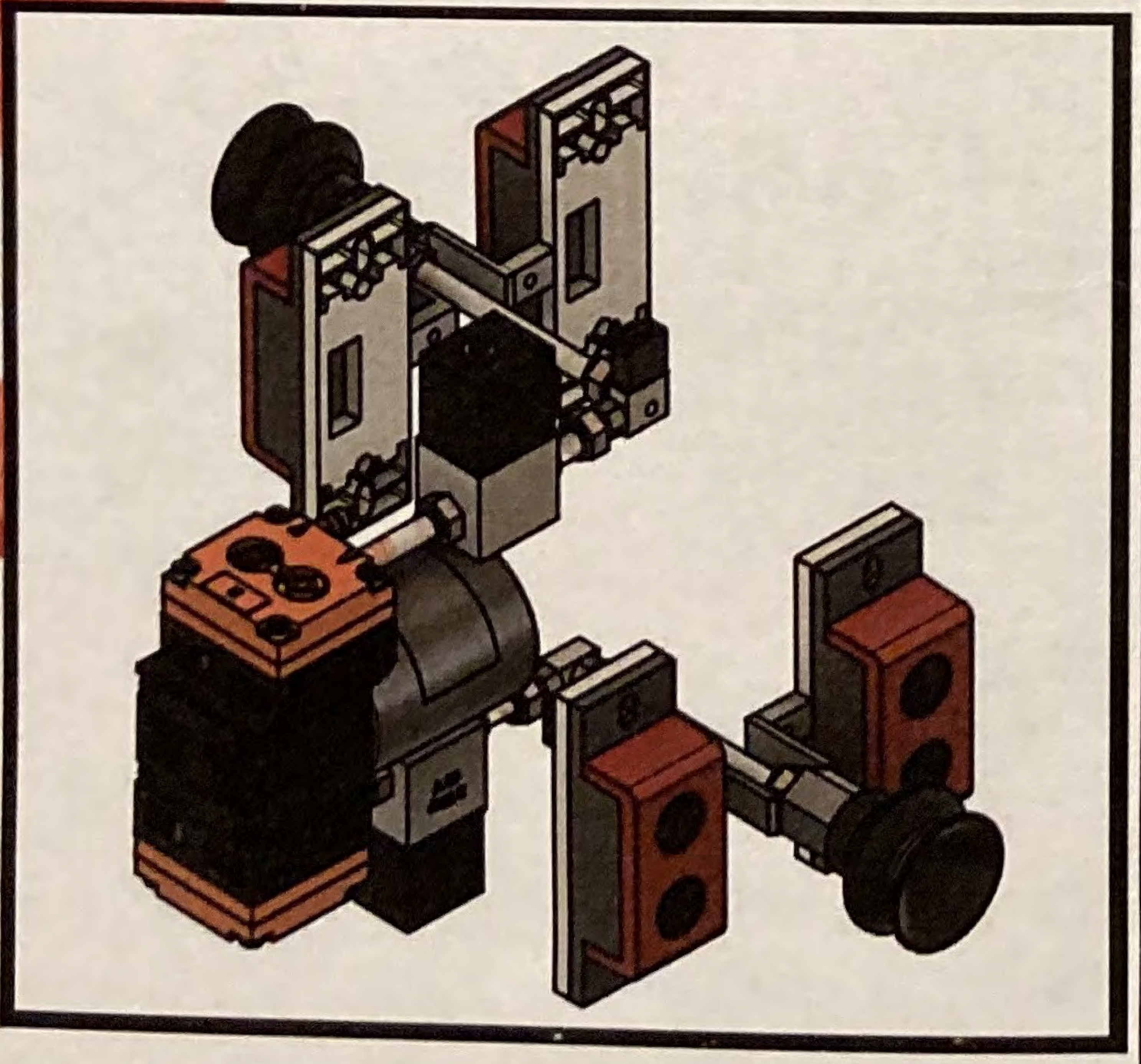
Suggestions for Kwadropus Suction Cups

- Have good drawings of your suction cups and why that style and material are important.
- Demonstrate attachment and release of your suction cup on a smooth flat surface and on a smooth curved surface.
- How sharp of a curve can your suction cup fit on?
- How and where do you expect your suction cups to fit on a Mobility Arm? Keep in mind the equipment to activate your suction cup. How many per arm?
- If the Kwadropus shrinks down to 12 inch diameter to clean in smaller nooks and crannies, how will your suction cup equipment scale down?

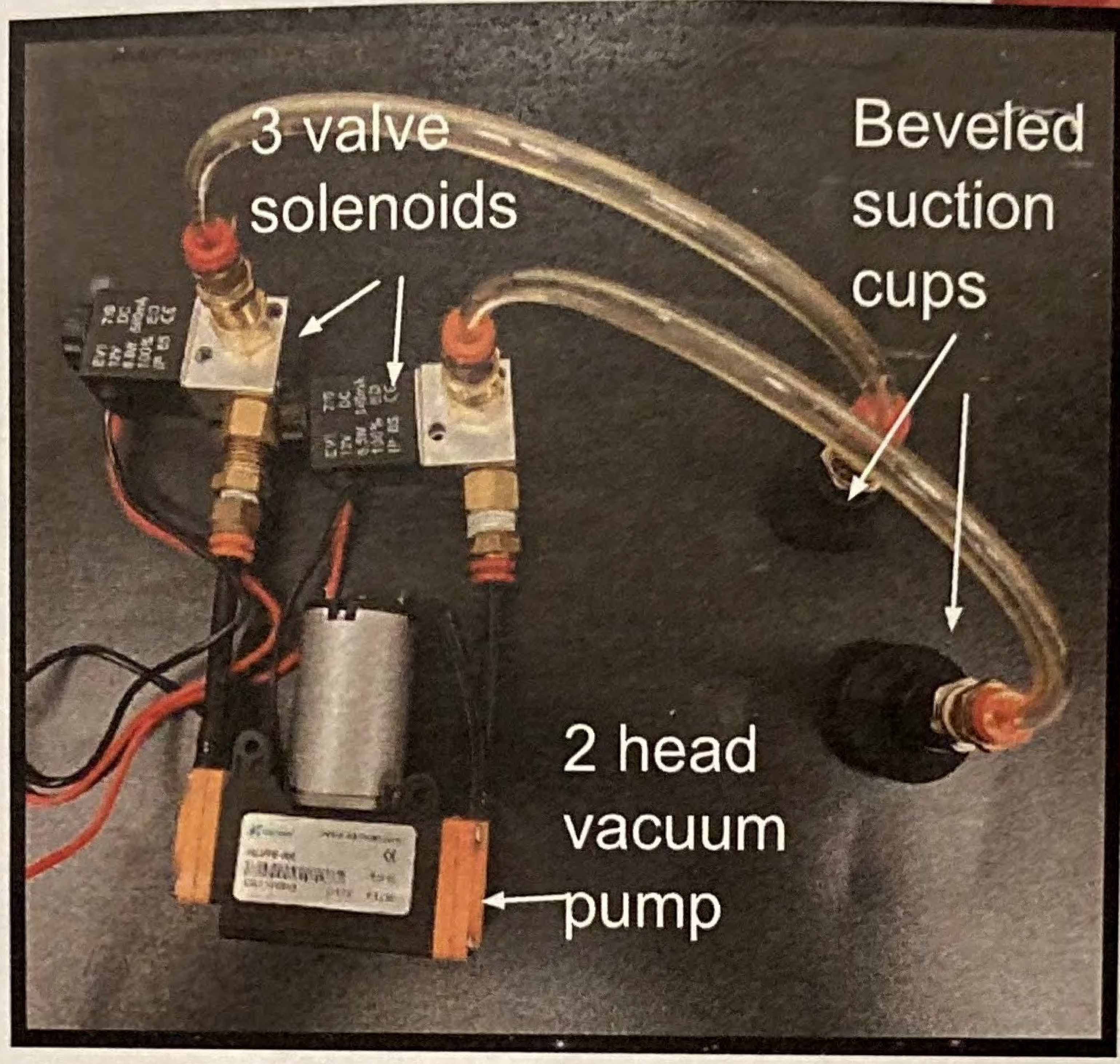
Criteria

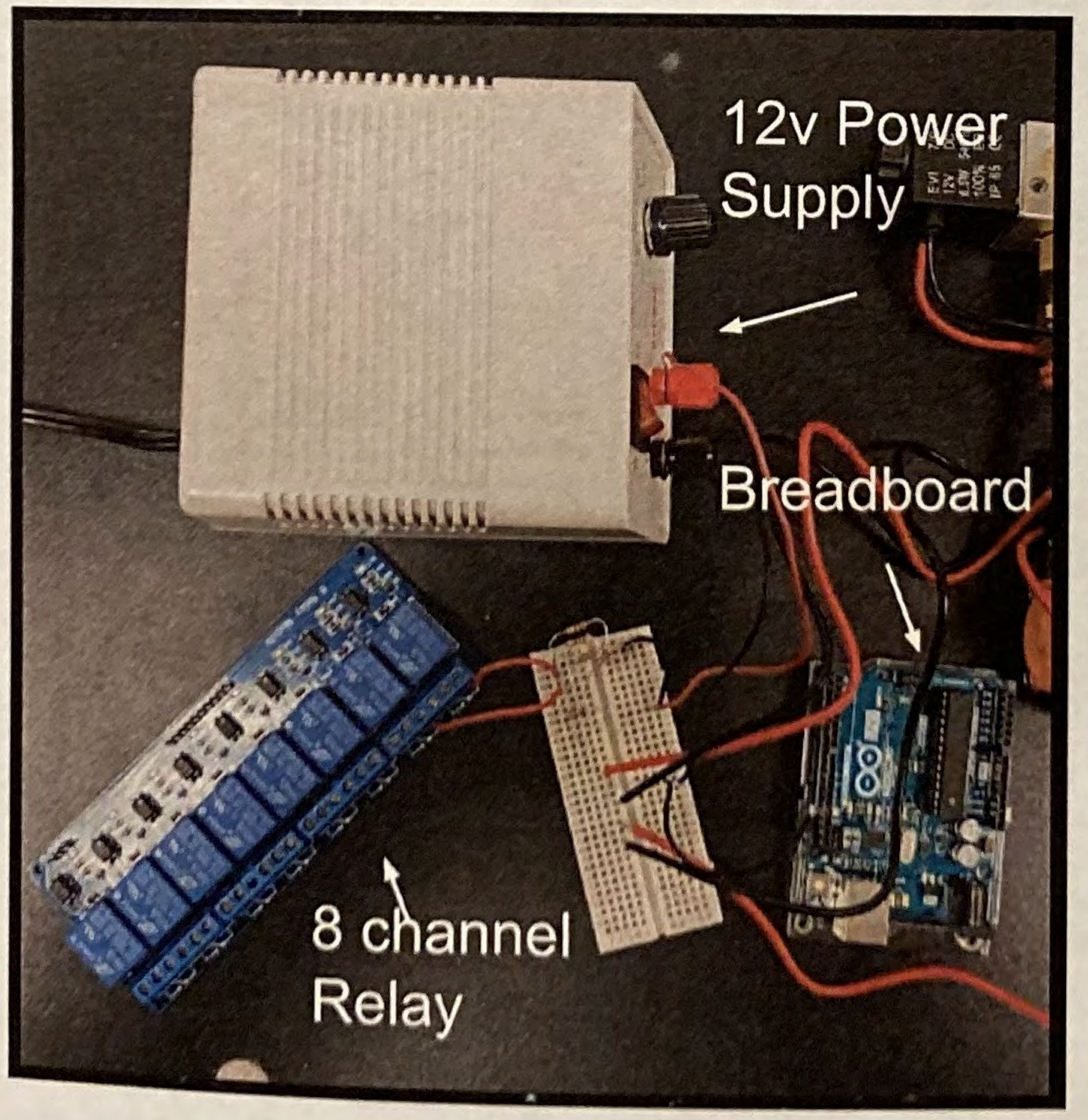
- Develop autonomous robot to clean the ISS
- Utilize suction cups to attach to surfaces
- Operate under 71°F
- Attach to walls
- Create and detect vacuum seal

Final CAD



Prototype





Test Results

Average Holding Time 1kg (M:SS.XX)

Flat Vertical:	6:34.67
Flat Horizontal:	4:57.42
Flat Vertical Dust:	1:45.64
Flat Horizontal Dust:	0:11.86
Curved Vertical:	4:37.01
Curved Horizontal:	3:47.76
Curved Vertical Dust:	0:08.62
Curved Horizontal Dust:	0:04.30

Other Tests

Sonar at 58db :	Pass
Sonar at 72db:	Pass
Check Valve:	Fail
Solenoids:	Pass

Problem Justification:

- Dust to travels more in space
- Dust contains dangerous chemicals (PFAs)
- Eliminate 2-4 hour weekly cleaning

2 Cup System Product List:

- 8 channel Relay
- Arduino Nano
- Ultrasonic sensor
- 2x suction cups
- 2x 3 way solenoids
- 2x 2 way solenoids
- 12v power supply
- Tube fittings
- Pneumatic tubing
- 2 headed vacuum pump

The Team:

Elliot Casson Jonathan Okorie

Our Website:

Contact us here:

ghssuctionarm@gmail.com

Kwadropus Suction Arm

Jonathan Okorie
Elliot Casson
Glenelg High School

Suction Arm

GHS

NASA HUNCH

Team ESCAPE

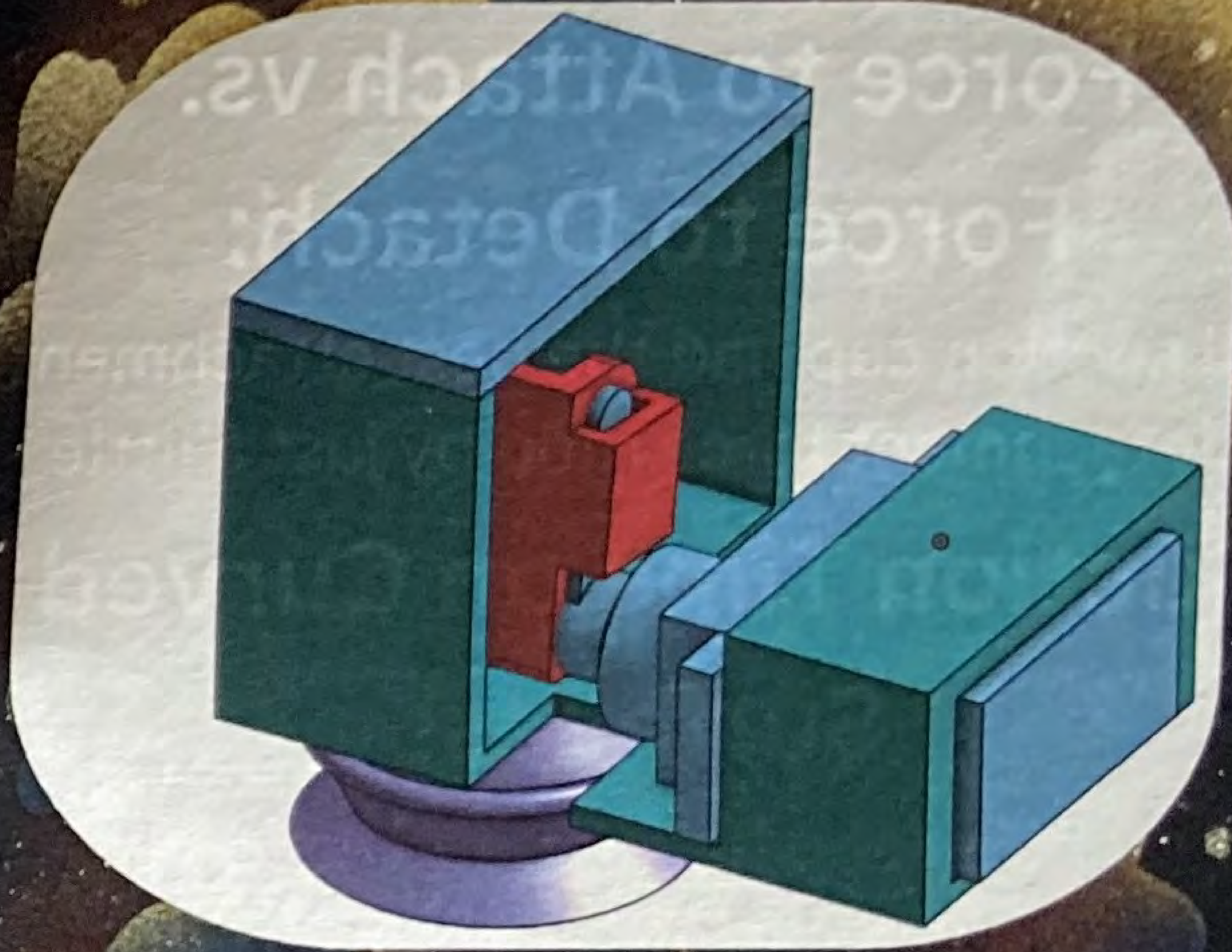
Kwadropus Cups

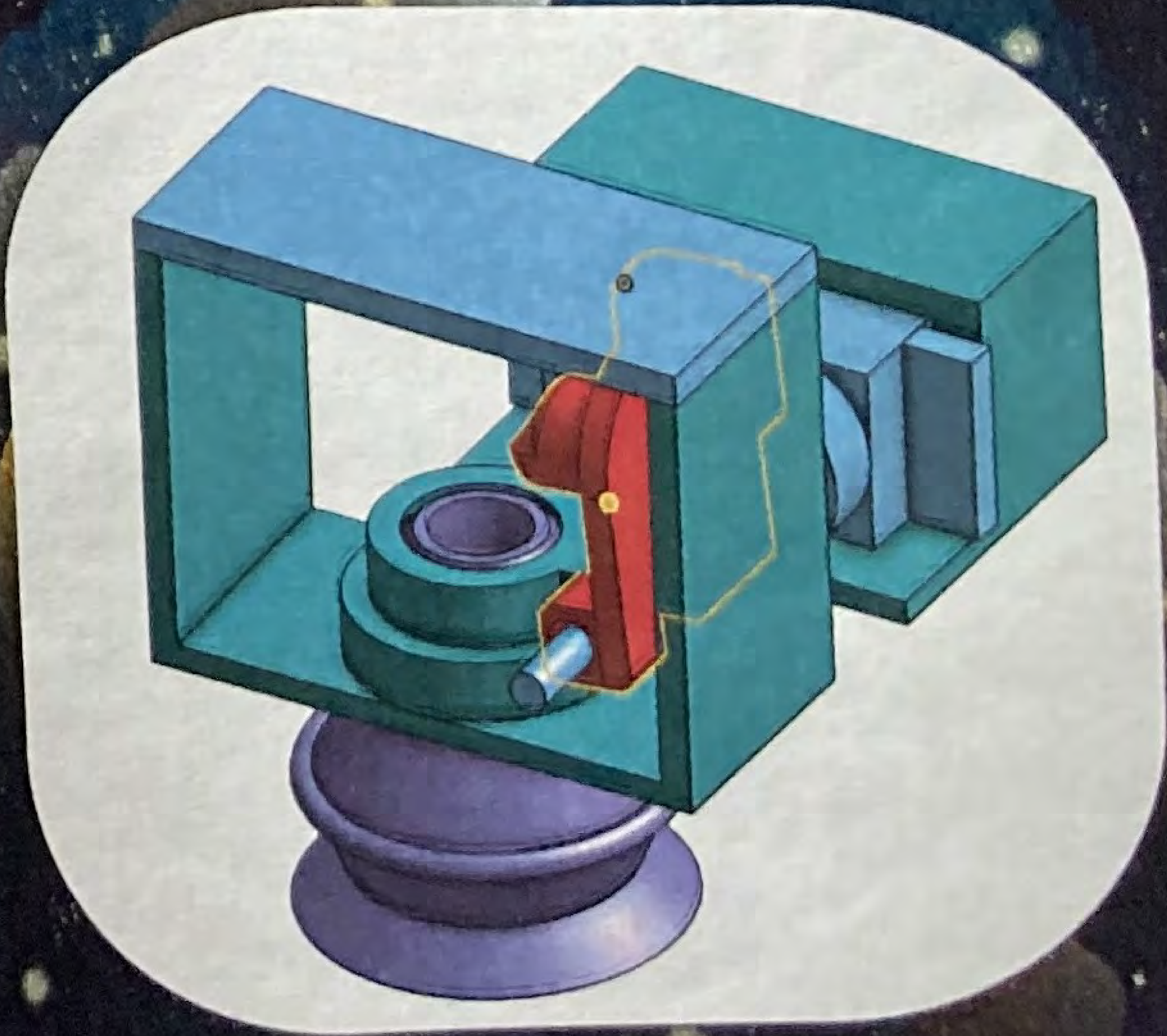
Kwadropus suction cups
School: Jackson Hole High School Team # 1

Jackson Hole High School
Jackson, WY

Teacher:
Keane Anderson (Mr. Anderson)

Creators:
Emma Blount
Eli Olais
Aidan Kim-Miller





Testing Summary

Force to Attach vs. Force to Detach:

Small suction cup had the best attachment to detachment force ratio by just a little

Suction Time on Curved Surfaces:

Large suction cup held on for the longest and was followed closely by the medium cup

Suction Time on Various Angles:

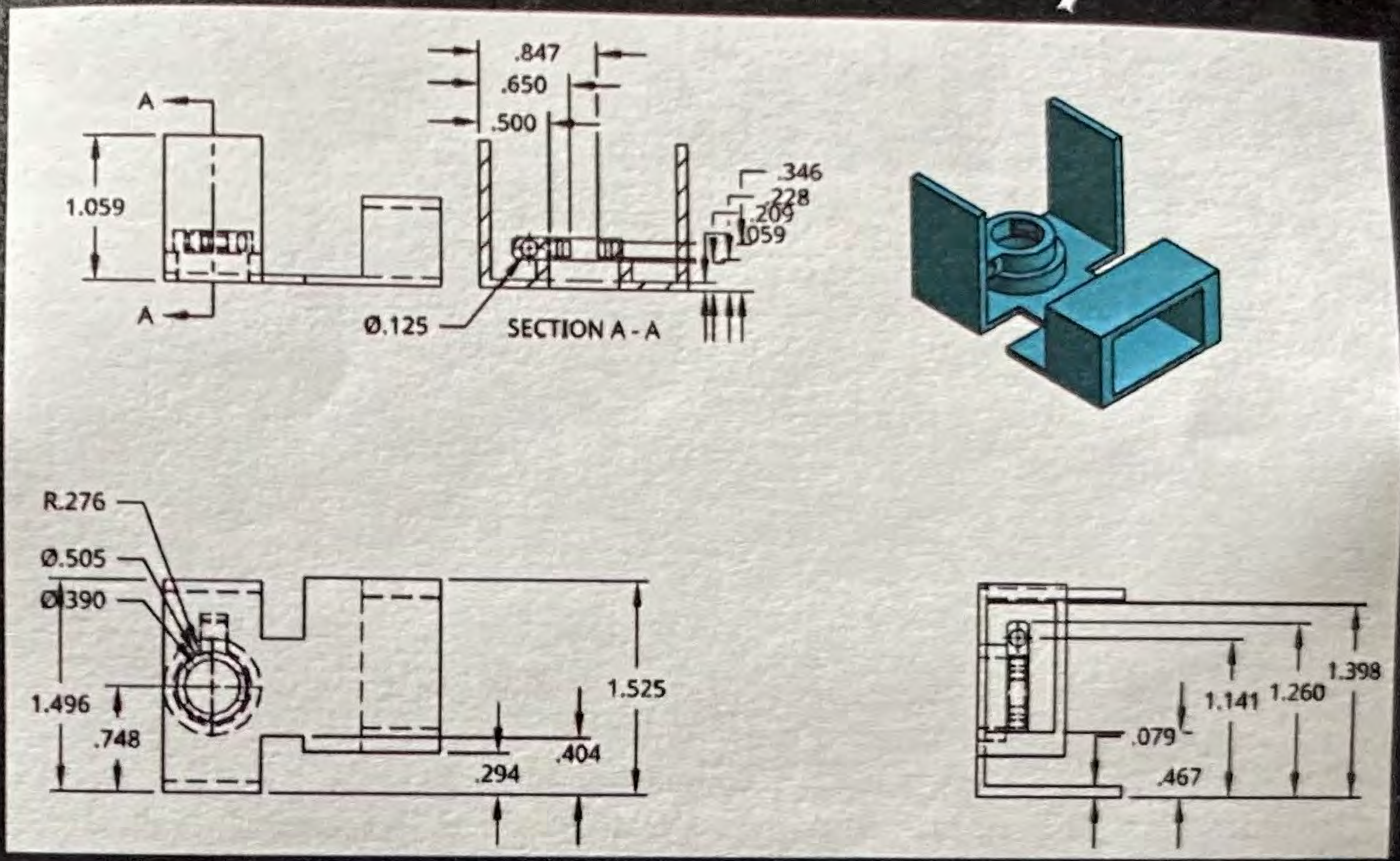
Large suction cup performed slightly better than medium once again

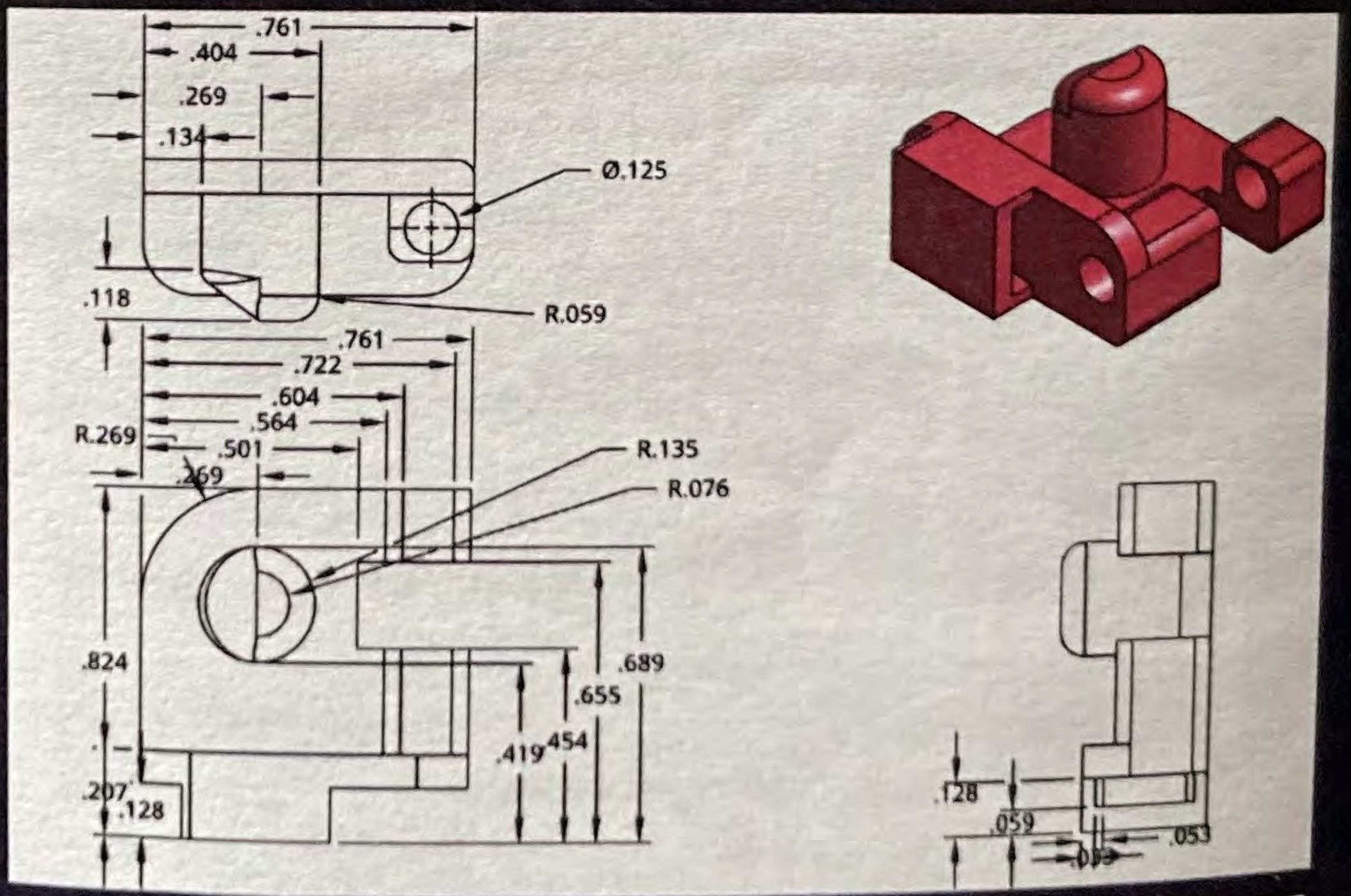
Suction to Various Surfaces:

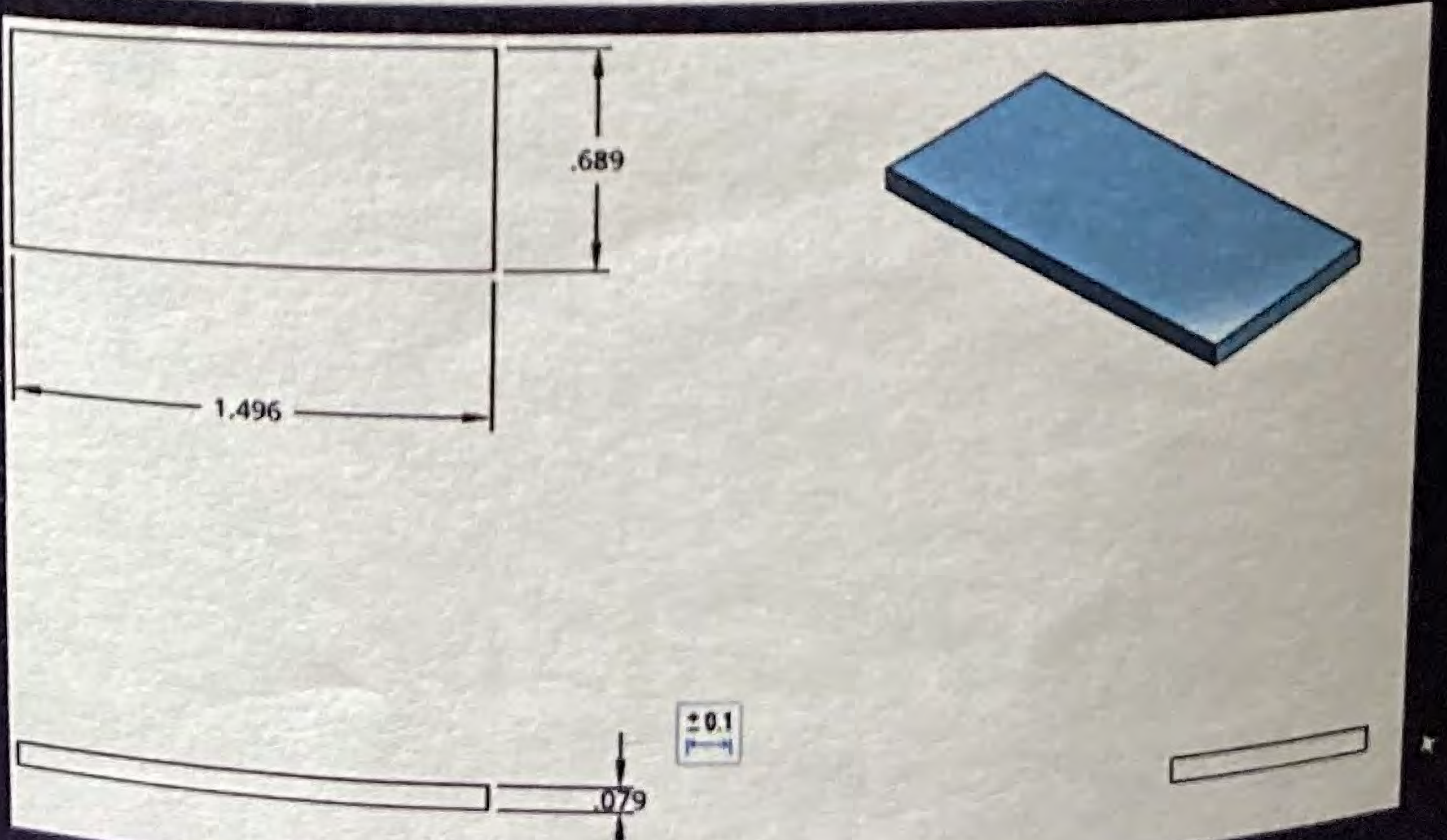
All suction cups can suction to metal and plastic of various textures

View Detailed Testing and Analysis Here:

Final CAD Drawings







Final Prototype

How it works:

1) Kwadropus arm applies pressure
2) Button or sensor that can be implemented tells the servo to close
3) Servo closes and the suction cup shape creates the suction
4) Kwadropus can release the servo when it wants to so that it can move the arm

Selling point(s):

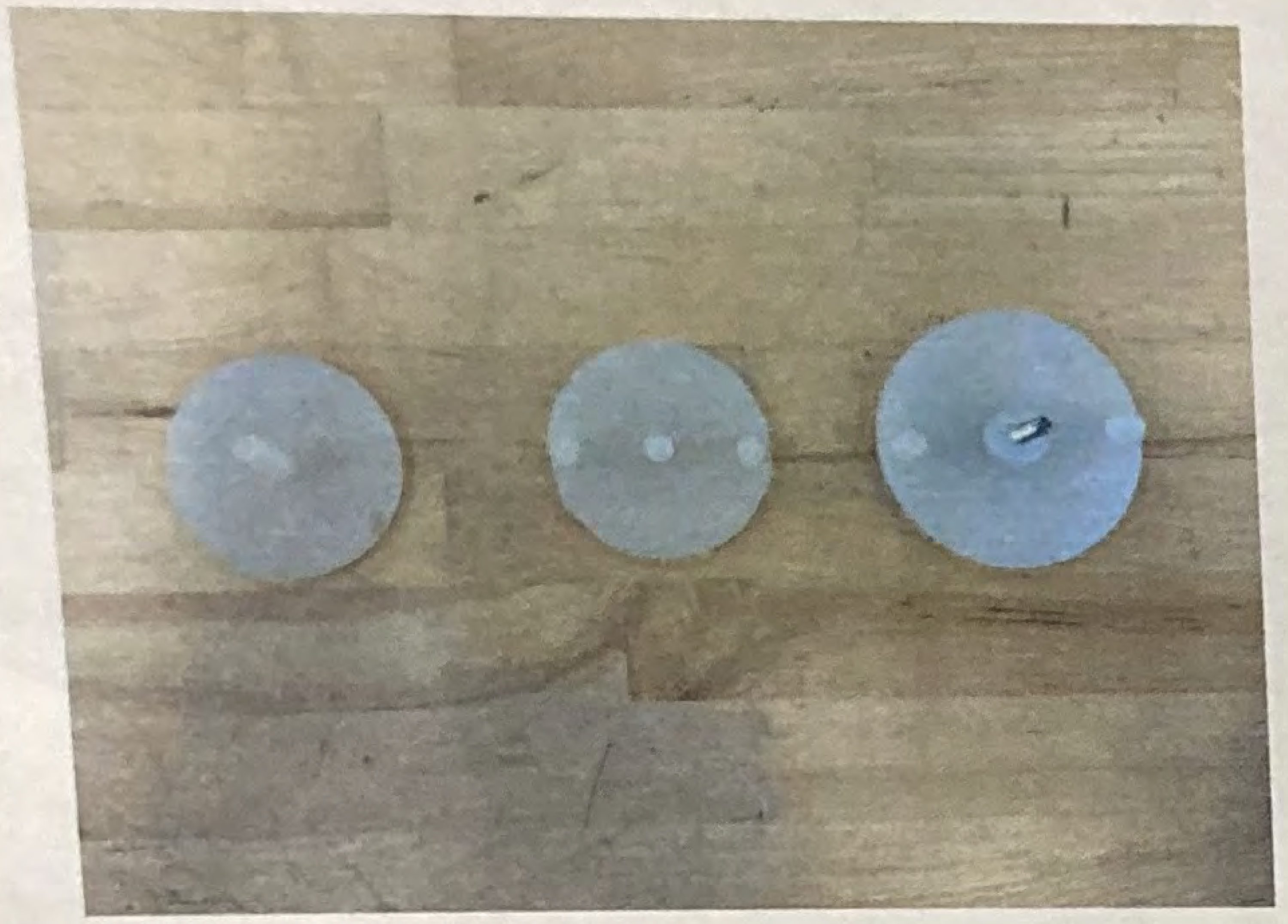
- Easy to change and replace suction cups
- Inexpensive and simple
- Light

Requirements and Constraints:

- Light weight of 21.3g
- Suctions to both flat and curved surfaces
- Depending on the suction cup can grip for upwards of 15 minutes
- The small cup has been proven to have a ratio of beyond 1:1 of suction forces
- 3d printed holder cost <$1 and the suction cups cost ~$7 from Grainger Industrial Supply

Future Innovations:

- Stronger servo (more torque)
- Streamline wiring
- Add a sensor to the bottom to determine when there is adequate compression



(From Left to Right) Suction Cup Versions 1, 2, 3

Problem Statement

How would we design a suction cup that works in a microgravity environment?

Important Questions:

What's the best design for a suction cup?

What material should it be made from?

Would our suction cup even work?

Our Purpose:

We need to solve the issue of anchoring the robot onto surfaces to help it maneuver in a micro-gravity environment

Video Demo

NASA HUNCH

Suction Cups

BY

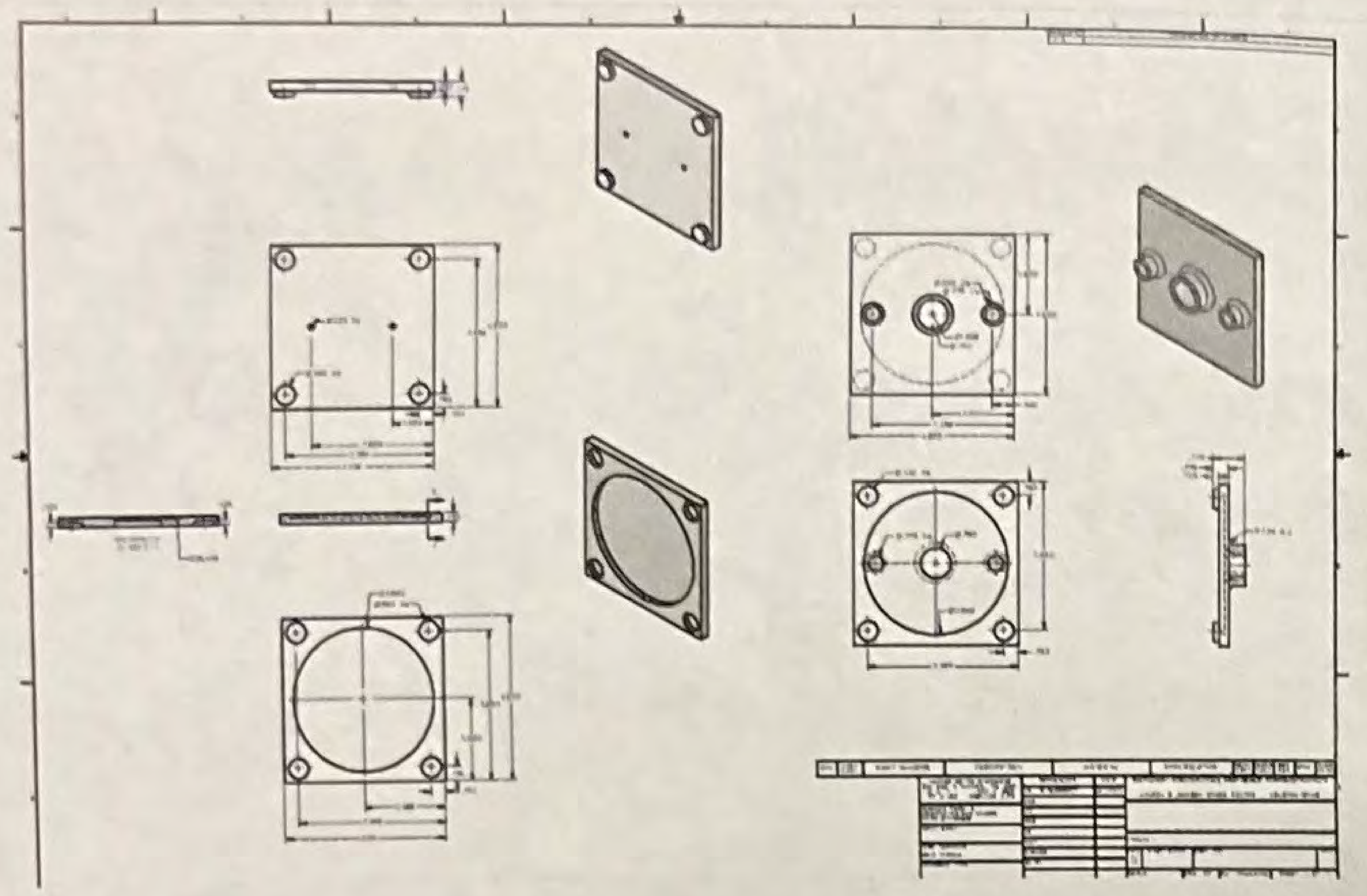
CARL BALITBIT AND KONNER WETTERSTROM

FOR
MR. ROBIN MERRITT

ARCHITECTURE AND CIVIL ENGINEERING

CLEAR CREEK HIGH SCHOOL

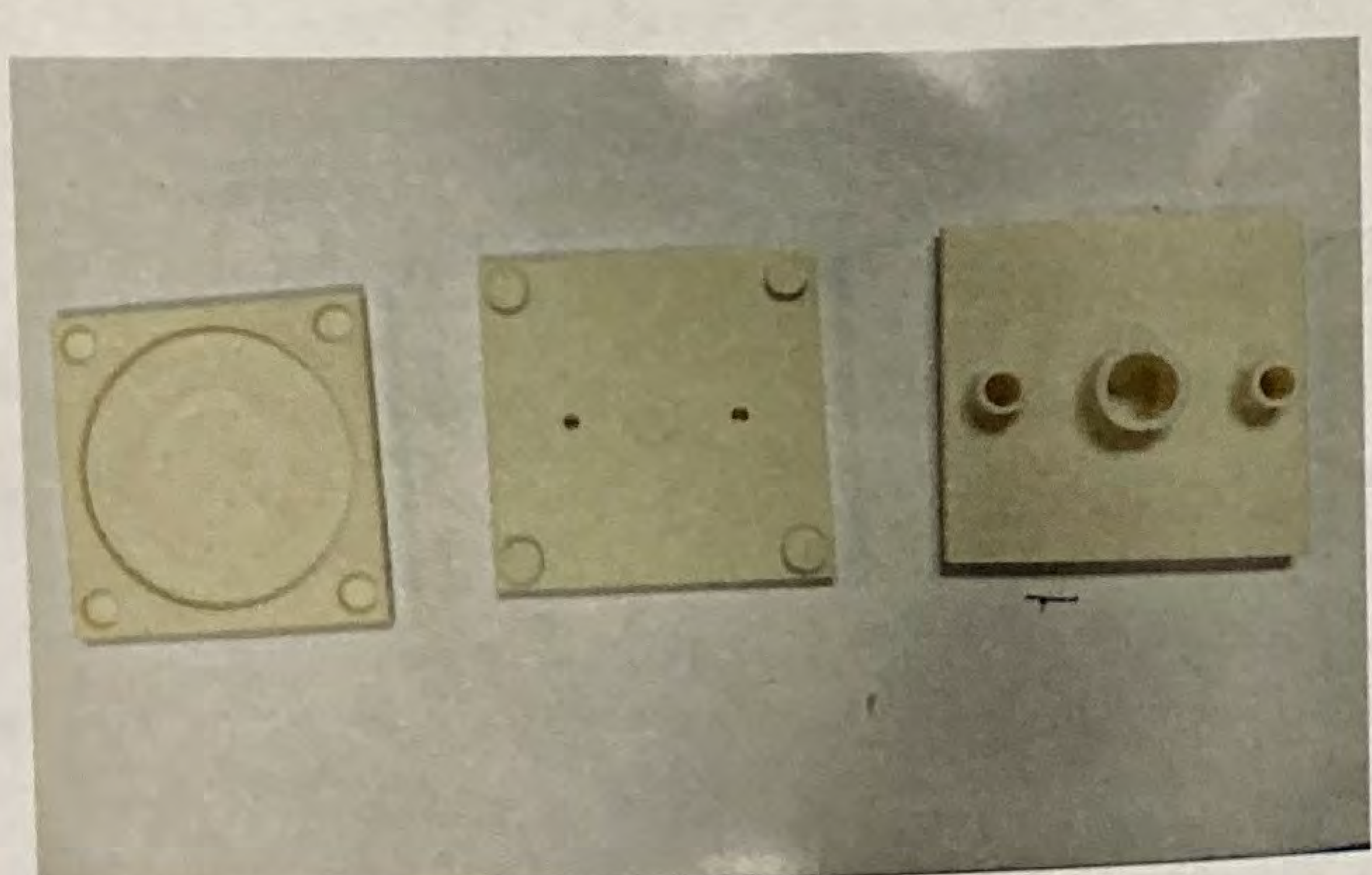
CLEAR CREEK ISD
LEAGUE CITY, TX 77573



Design – The Mold

Our design was originally meant to be 3d printed using a flexible material, however we changed our process to use a mold, and to pour a 2-part silicon mix to cast our suction cup. Our first mold design had 2 pieces, but our final design has 3.

Our newest mold has 3 pieces: A base, and 2 tops. To create the suction cup, we used 2 separate pours of silicon mix. The first pour utilized the base and top 1, and it made a silicon base with a rounded bottom. Before pouring a second time, we let the first pour set, and afterward replaced top 1 with top 2. After placing a bolt in the center, resting on top of the hardened silicon, we poured in our second batch. This simply joined the 2 halves of silicon, encasing the bolt in the center, creating our suction cup.



The Suction Cup

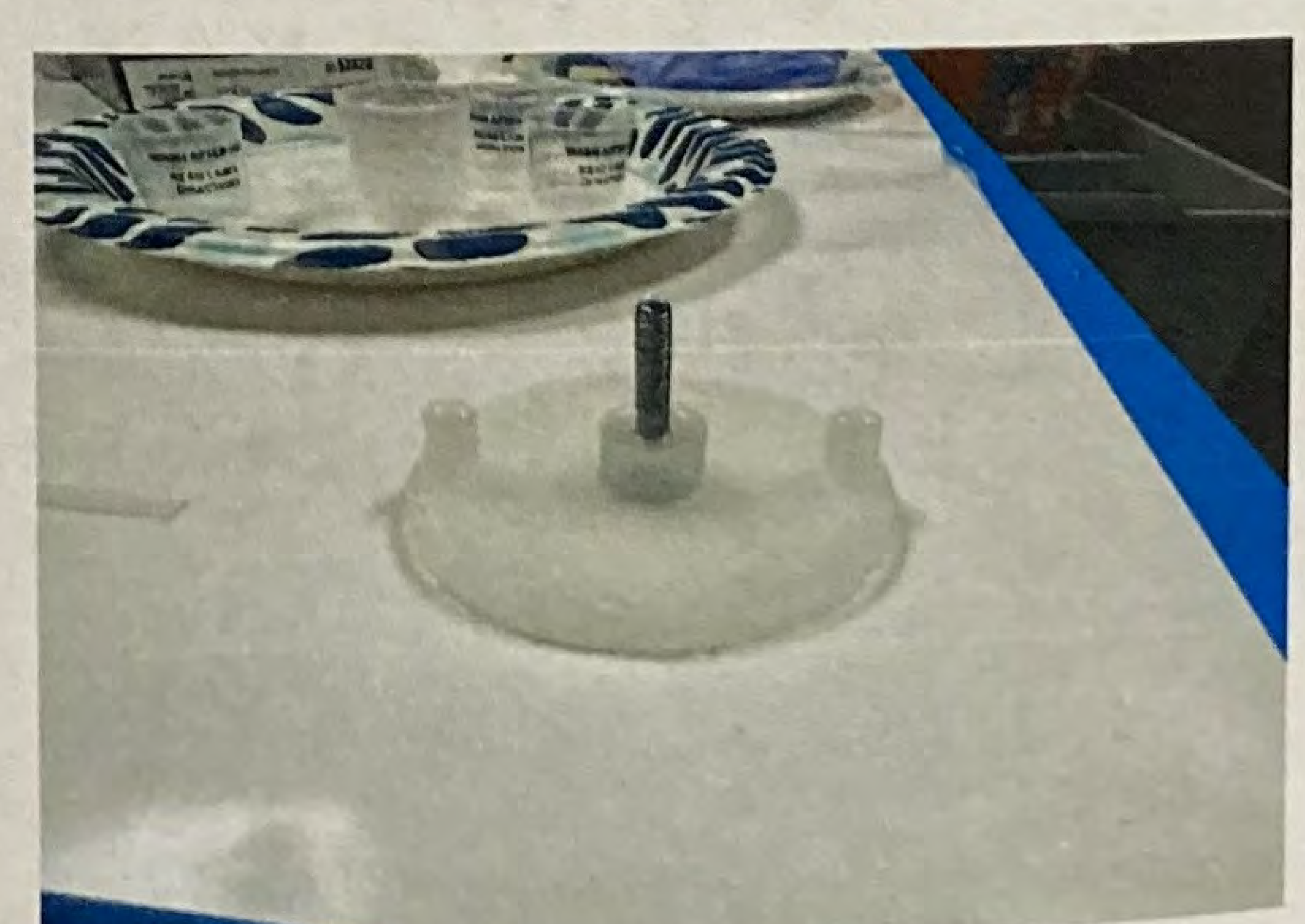
After letting the silicon mix set overnight, the cup could be easily removed from the mold. Our first iterations involved 3 pegs, all made from silicon. However, our final design uses a bolt as a central peg.

How does it stick?

The base of our suction cup is a slightly rounded basin, which lands on smooth and curved surfaces. Since the basin is so small, you do not need to push a force down on the cup. Since pulling this peg only pulls from the center, the center of rounded basin gets lifted while the cups edges remain on the surface. This creates a difference of pressure inside of the cup, allowing it to withstand a lot of force pulling up. Using a bolt instead of silicon for this peg proved effective, as the bolt cannot flex like the silicon did, this allows the force to be more uniform, which improves its strength. In the actual robot, this bolt could simply be screwed into any attachment points.

How does it unstick?

This is where the outside pegs come in to play. Tugging one of these lifts the edge of the cup which breaks the seal. In the actual robot, these pegs would be hooked up to a motor and string, where the brain of the robot would tell the motor to tug on these pegs when release is needed.



Our Process

Before we began our project, we spent the first few weeks researching and planning our suction cup.

Once we were set on a material and general design, we began the mold creation and silicon pouring.

Once our suction cup was cured we would then test it on various surfaces and then brainstorm potential upgrades that we can make.

Once we found a shape that worked well, we then went to designing the attachment and detachment points for future integration onto the robot.

Eventually we landed on our final design which was the accumulation of our research and testing.

About Us

Carl Balitbit - Senior
carlbalitbit@gmail.com

Konner Wetterstrom – Junior

kewetterstrom@gmail.com

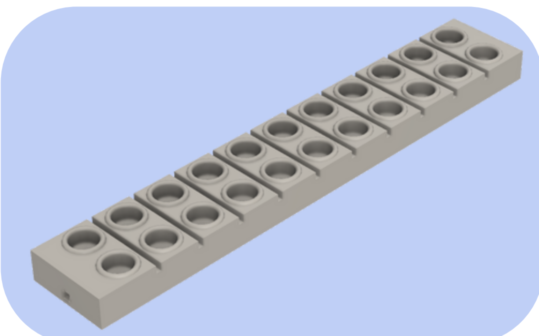
NASA Hunch

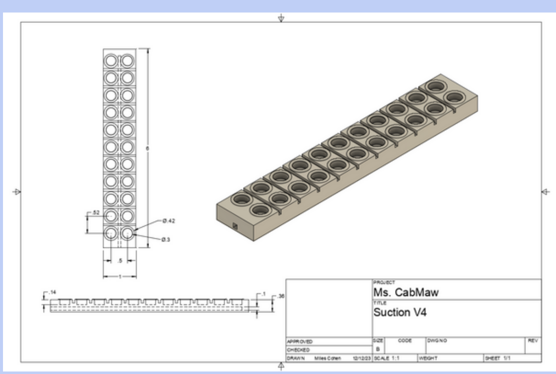
Kwadropus Duster Robot - Suction Cup

Madeline Ampleman, Alayna Beck, Miles Cohen, and Samuel Wilson

School: SMSD Center of Academic Achievement

Teacher: Renee Chambers





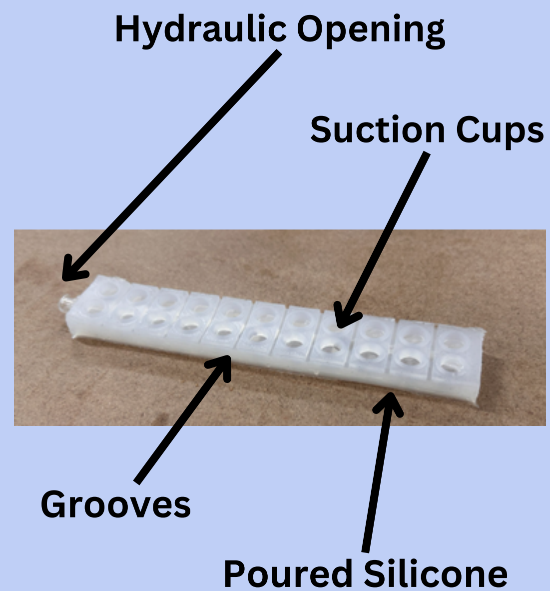
Description:

This design utilizes liquid-filled channels within a pliable silicone manifold to individually actuate an array of suction cups through the deformation of an internal membrane.

This design assists the Kwadropus Duster Robot in securing itself as it maneuvers through the space station. The use of low-hardness silicone in the design allows for a calculable amount of deformation to curved surfaces while ensuring that the precise geometries of the design are preserved.

This design allows for reliable use on both curved and flat surfaces. The use of an incompressible fluid in the channels allows for a predictable amount of pressure exerted by the suction array due to a constant internal volume.

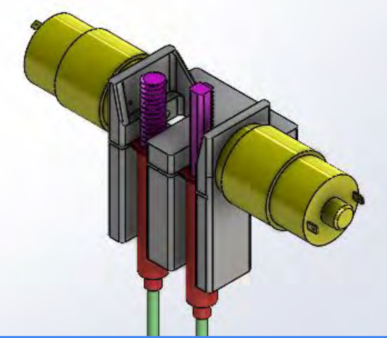
Link to Video Pictures and documentation

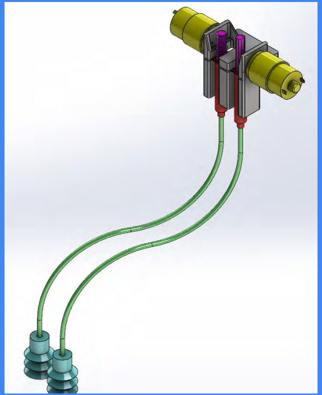


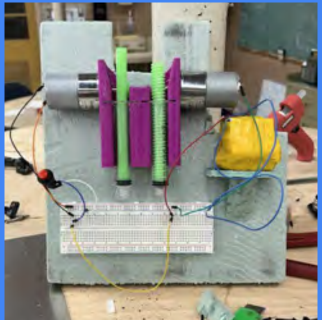
NASA Suction Cup Project Kettering Fairmont High School

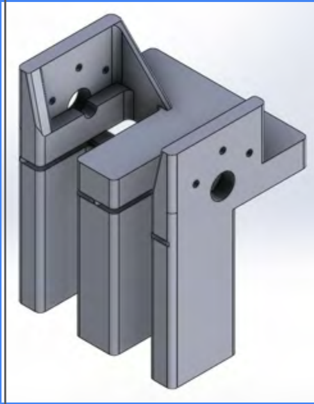
By: Ben Ross, George Goodson

Teacher:Brett Jenkins









- We are using a vacuum cup instead of a suction cup because of the versatility and the flexibility of the cup. We also are using this because it can wrap around a curved surface easier than a regular suction cup.
- The mecanicien we are using is a worm gear and a regular sprocket to create a suction.
- We also use a hard plastic tubing to ensure the vacuum caused by the sarenge with not compromise the structure of the tube.

Video’s

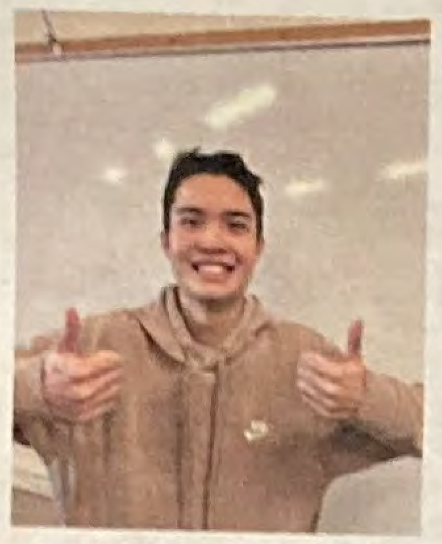
QR Codes

Data

Videos

Meet The Team

Jacob Hoshiko



2109656@jeffcoschools.us
720-568-0037
Electronics & Coding

William Luo

2189436@jeffcoschools.us
720-270-7747
3D Modeling & Design

Max Shay

2109144@jeffcoschools.us
303-521-8292
Manufacturing & Molding

Evan Haines

2111793@jeffcoschools.us
720-795-3543
Material Research & 3d Printing

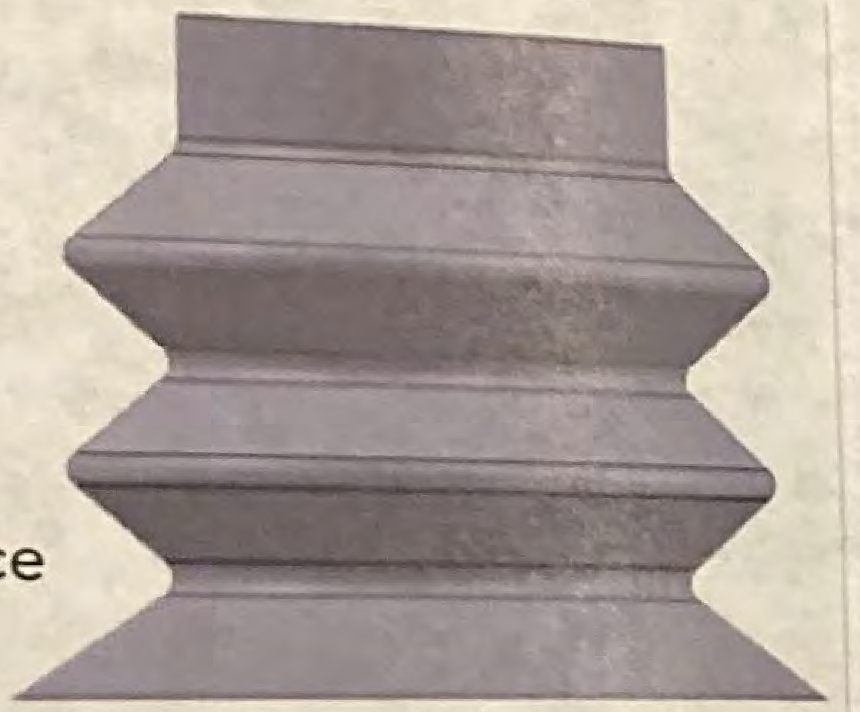
Instructor: Fabian Brunetti
School: Chatfield Senior High
State: Colorado
Year of Project: 2023-2024

SUCC

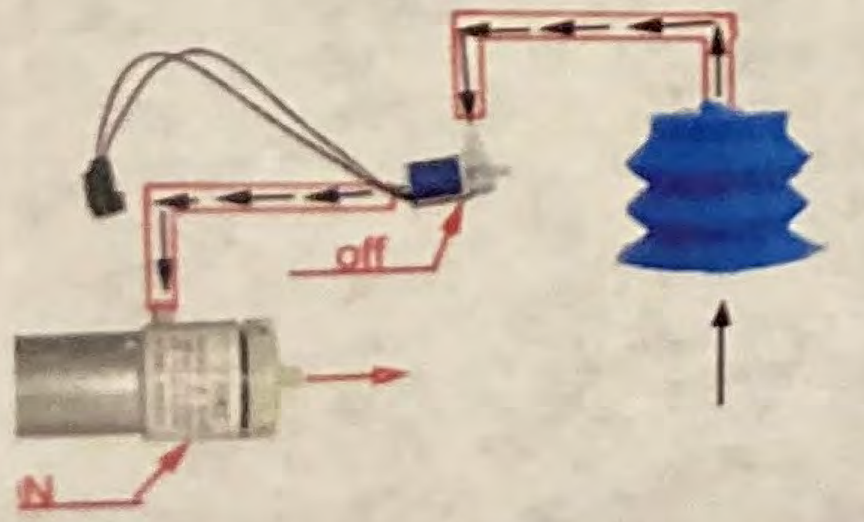
Suction Universal Contraption Creators

OUR DESIGN

BELLOWS



Our suction cup incorporates a multi-bellow design. Bellows allow the suction cup to become extremely versatile, being able to adhere to different surface angles/curves as well as providing a consistent attachment no matter the approach angle

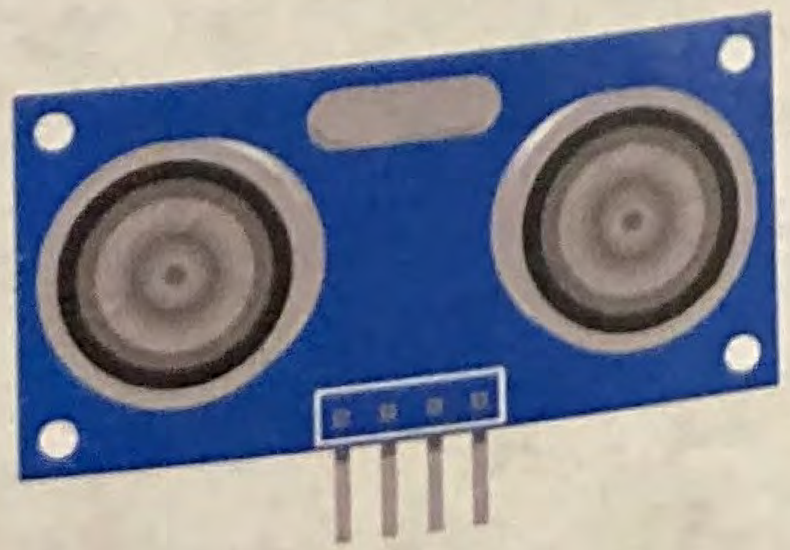


PNEUMATIC SYSTEM

Our design is activated automatically with pneumatics, using an electronic air pump and a 3-way solenoid valve. The pump is used to move air and cause the pressure differential and the valve allows us to control when and just how fast to release the pressure

ULTRASONIC SENSOR

Our design makes use of an ultrasonic sensor. This sensor uses ultrasonic sound(40 kHz), that cannot be heard by the human ear, in order to determine proximity to a surface. This allows us to automatically suction on and know when a successful attachment

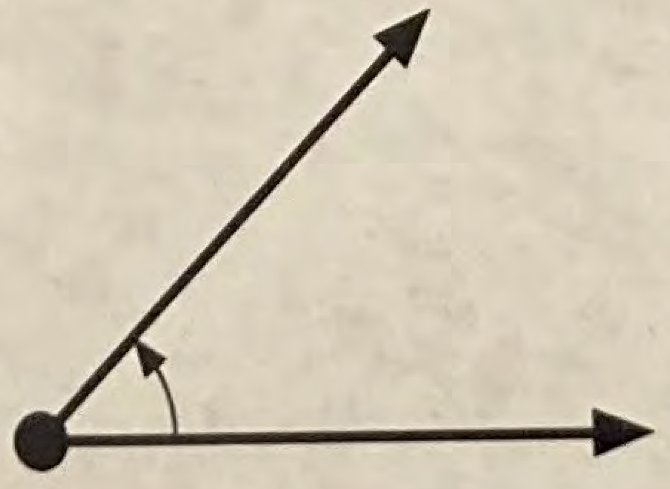


TESTING

HOLDING STRENGTH

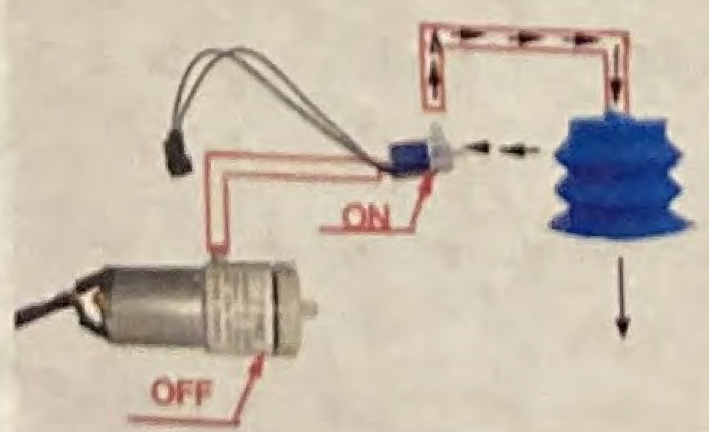
With our design and vacuum pump, we are able to hold up a maximum weight of around 32 ounces (2 pounds). The specification we were given by NASA was 10 ounces, however we were able to carry 3X the specified amount even with a rough and slightly curved surface.

SURFACE & APPROACH ANGLE



Our design allows us to attach to not only flat surfaces but concave and convex surfaces. With our design we are able to consistently suction onto curves that are at a 90 degree bend. We also tested this using anodized aluminum which is the primary material o on the ISS.

DETACHMENT



The detachment of our suction cup does not create any unnecessary force that could move the Kwadropus robot. This is accomplished because we can change the time interval for the pressure release, which through testing can maximize speed without unwanted thrust.

WHY US?

VERSATILITY

With our suction cup design, we are able to attach to different surface types with different curvature and at different angles. Our design is also programmable, allowing the use of different suction intervals.

POWER & EFFICIENCY

The entire system can be powered with a single 9V battery, while still maintaining our impressive holding strength. This accomplished by varying the activation times of each component so that total load never exceeds to power supply.

REPAIRABILITY & REPLACEABILITY

With our current material -silicone- our suction cup is easy to repair or replace. If one of our suction cups were to rip or take damage, it can be resealed and repaired by applying liquid silicone rubber to the rip or it can be simply replaced.